
Table of Contents

1	INTRODUCTION	1
	References.....	5
2	CONTAMINANT CHARACTERISTICS	7
2.1	Introduction.....	7
2.2	Physical and Chemical Parameters.....	7
2.3	The Contaminants.....	13
2.3.1	Inorganics.....	14
2.3.2	Organics.....	16
	References.....	24
3	EXPOSURE CHARACTERISTICS	31
3.1	Demographics.....	32
3.1.1	Relationship to Activity Patterns and to Building and Water Source Characteristics.....	32
3.1.2	Selecting a Basic Demographic Group.....	33
3.1.3	Applicable Census Data and Survey Results.....	33
3.1.4	Representation of National vs. Local Population Groups.....	39
3.1.5	Characterization of Sensitive Populations.....	40
3.1.6	Data Gaps and Research Needs.....	40
3.2	Consumption and Time/Activity Data.....	41
3.2.1	Principal Activities.....	41
3.2.2	Indirect (Second-Hand) Exposures.....	45
3.2.3	Variation among Population Groups.....	45
3.2.4	Applicable Databases.....	47
3.2.5	Ongoing Studies.....	65
3.2.6	Data Gaps and Research Needs.....	65
3.2.7	Primary References.....	65
	References.....	66
3.3	Building Characteristics.....	68
3.3.1	Residence Types and Subtypes, and Their Volumes.....	70
3.3.2	Air Exchange Rates.....	72
3.3.3	Airflow Between Rooms and Zones.....	72
3.3.4	Key Factors Affecting Degree of Air Exchange and Airflow.....	73
3.3.5	Applicable References and Databases.....	74
3.3.6	Data Gaps and Research Needs for Building Characteristics.....	74
3.3.7	Additional Publication.....	75
	References.....	75

3.4	Water Source Characteristics	77
3.4.1	Analysis of System Components	77
3.4.2	Estimation of Source Water Quality	79
3.4.3	Data Gaps and Research Needs	83
	References.....	83
4	DEVELOPING EXPOSURE ESTIMATES.....	85
4.1	Introduction/Overview.....	86
4.1.1	Ingestion Exposure	86
4.1.2	Inhalation Exposure.....	87
4.1.3	Dermal Absorption	88
	References.....	88
4.2	Transfer of Volatile Compounds from Drinking Water to Indoor Air	89
4.2.1	Introduction.....	89
4.2.2	Henry's Law and the Mass-Transfer Coefficient	90
4.2.3	Predicting Mass-Transfer Rates	91
4.2.4	Measuring Mass-Transfer Coefficients	95
4.2.5	Relationship between $K_{OL,A}$, $K_{OL,a}$, and TE.....	96
4.2.6	Nonideal Conditions.....	97
4.2.7	Current State of Knowledge.....	97
4.2.8	Future Work.....	99
	References.....	100
4.3	Aerosols and Water Droplets	101
4.3.1	Definitions (Aerosols, Droplets)	101
4.3.2	Water Uses as Sources of Droplets/Aerosols.....	103
4.3.3	Lifetime of Droplets and Aerosols.....	104
4.3.4	Integration of Processes.....	107
	References.....	109
4.4	Water (Direct Contact).....	110
4.4.1	Principles	110
4.4.2	Chemical Characteristics	111
4.4.3	Knowledge Gaps.....	114
	References.....	114
4.5	Modeling of Exposure to Waterborne Contaminants	115
4.5.1	Introduction.....	115
4.5.2	Modeling Methods.....	116
4.5.3	Representation of Input Parameters	121
4.5.4	Knowledge Gaps.....	121
	References.....	122
5	RESPIRATORY UPTAKE.....	125
5.1	Introduction	125
5.2	Regions of the Respiratory Tract.....	126

5.3	Models for Assessing Respiratory Dosimetry	128
5.4	Sources of Airborne Drinking Water Toxicants.....	131
5.4.1	Volatile Gases	131
5.4.2	Aerosols	131
5.4.3	Other Sources	132
5.5	Physiologic and Pharmacokinetic Factors	132
5.5.1	Respiratory Parameters.....	132
5.5.2	Other Factors	133
5.6	Model Estimates of Lung Toxicant Uptake.....	133
5.6.1	The Contribution of Shower Aerosols to Uptake	133
5.6.2	Comparison of Inhalation and Dermal Uptake.....	133
5.7	Summary.....	134
	References.....	134
6	DERMAL UPTAKE.....	137
6.1	Introduction	138
6.1.1	Exposure to Vapors.....	138
6.1.2	Exposure to Aerosols.....	139
6.1.3	Exposure to Liquid Water	139
6.2	Barrier Properties	139
6.2.1	Fick's Law	139
6.2.2	Skin Structure	143
6.2.3	Regional Variation	145
6.2.4	Effect of Skin Damage.....	146
6.2.5	Effect of Temperature and Blood Flow Rate.....	147
6.2.6	Effect of Hydration.....	148
6.2.7	Effect of Soaps and Surfactants	148
6.2.8	Effect of Ionization.....	149
6.2.9	Consideration of Special Populations	150
6.2.10	Summary	150
6.3	Types of Skin Penetration Data	150
6.3.1	Ways to Express Penetration.....	150
6.3.2	Experimental Methods.....	153
6.3.3	Sources of Penetration Data.....	157
6.3.4	Correlations from Many Data Sets	158
6.4	Mathematical Models of Penetration.....	168
6.4.1	Membrane Models.....	168
6.4.2	Pharmacokinetic Models	170
6.5	Recommendations of Experimental Methods for Water Exposures	173
6.6	Recommendations for Use of Penetration Data for Risk Assessments	175
	References	176

7 CASE STUDY	183
7.1 Introduction	184
7.2 Modeled Residence	184
7.3 Activity Patterns	185
7.4 Water Uses	188
7.4.1 Simulating Water Use Occurrences.....	189
7.4.2 Simulating Water Use Durations.....	191
7.4.3 Humidifier Water Uses	192
7.5 Modeling Contaminant Emissions During Household Water Uses	192
7.5.1 Volatilization Models.....	192
7.5.2 Model Inputs for Water-Using Devices	194
7.5.3 Aerosol Emissions	195
7.6 Modeling Absorbed Dose.....	200
7.6.1 Absorbed Dose due to Vapors.....	200
7.6.2 Absorbed Dose due to Aerosols.....	202
7.6.3 Absorbed Dose due to Dermal Contact	203
7.7 Results	205
7.7.1 Results of a Selected Case	206
7.7.2 Results of Population Dose Distribution	209
7.7.3 Discussion	217
7.8 Conclusions	221
References.....	223
INDEX	225